Sounding Rocket Working Group

SRPO Summary

June 16, 2005

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Presentation Outline

- FY05 Mission Results Summary (to date)
- FY05-FY08 Manifest
- Anomaly Investigation Status
- Accomplishments
- Studies
- Foreign Missions
- Technology Update

- Findings from June SRWG Meeting
- Range Operations
  - Poker Operations
    - Annual Operations
  - Andoya Operations
  - Multiple Site Operations
- Rocket Motor Status and Vehicle Development

FY05 Mission Results

- 13 Total Missions (to date)
  - 4 Science
    - 1 WSMR and 3 Poker
    - One Failure (BBXII at Poker)
  - 2 Educational
    - High School Level (SubSem) – successful
    - University Level – successful
  - 2 Technology
    - Inertial ACS (spinning) – clamp release failure on vehicle. Able to validate ACS software changes
    - Inertial ACS (spinnnig) – validated inertial ACS in spinning mode
  - 5 Reimbursable
    - Vehicle support on 4 missions
    - Standardized technology carrier for Integrated Business Systems Inc (IBSi)

Heath 41.057
Launch
May 5 2005
5:35 AM
NSROC
Wallops Island,VA

FY05 Launch Schedule

#	Vehicle Type	FY 2005 Mission	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
		WALLOPS ISLAND												
1	Orion	HALL/VIRGINIA POLYTECHNIC UNIV.								▲				
2	Test Vehicle	HICKMAN/NASA										△		
3	Test Vehicle	KRAUSE/NASA-NSROC												△
4	Orion	JUSTICE/NASA - SubSEM									▲			
5	Terrier Orion	PLAYER/LARC											△	
6	Terrier Orion	HICKMAN/NASA												△
		WSMR												
7	Test Vehicle	KRAUSE/NASA-NSROC		▲										
8	Black Brant IX	WOODS/UNIVERSITY OF COLORADO	▲											
9	Test Vehicle	KRAUSE/NASA-NSROC				▲								
10	Test Vehicle	COSTELLO/NASA-NSROC									△			
11	Black Brant IX	RABIN/GSFC									△			
12	Test Vehicle	COSTELLO/NASA-NSROC											△	
13	Black Brant IX	KANKELBORG/MONTANNA STATE U.										△		
14	Black Brant IX	MCCAMMON										△		
		PFRR												
15	Black Brant XII	LYNCH/DARTMOUTH						▲						
16	Orion	LYNCH/DARTMOUTH						▲						
17	Orion	LYNCH/DARTMOUTH						▲						

FY06 Manifest

	Mission	Launch Date	Site	PI	Comments
1	12.059	Oct	WSMR	Costello (NSROC)	Slipped - Celestial ACS Demo #2
2	36.233	Oct	WSMR	McCammon	Slipped - Can use a NIACS
3	36.207	Jan	WSMR	Cruddance	Slipped
4	36.220	Feb	WSMR	McCandliss	Use new NSROC Celestial ACS
5	36.213	March	WSMR	Porter	
6	36.218	March	WFF	Earle	
7	36.224	May	WSMR	Cash	
8	36.221	June	WSMR	Moses	
9	36.219	June	WSMR	Hessler	
10	30.XXX	June	WFF	Education Office	SubSEM
11	41.056	June	Andoya	Wheeler (PSU)	International Outreach mission
12	41.XXX	TBD	WFF	NSROC	Potential Tech Demo Flight
	12.055	Feb	WFF	Krause	Limbo due to funding / Talos-Oriole Test Flight

FY07 Manifest

	Mission	Launch Date	Site	PI	Comments
1	36.233	Oct	WSMR	Woods	
	36.225	Jan	WSMR	Chakrabarti	Planet Imaging – Unique ACS requirement
2	35.038	Jan	PFRR	Lessard	Rocket assisted ejectable sub-payloads
3	21.138	Jan	PFRR	Larsen	JOULE 2
4	36.234	Jan	PFRR	Larsen	JOULE 2
5	41.064	Jan	PFRR	Larsen	JOULE 2
6	41.065	Jan	PFRR	Larsen	JOULE 2
7	35.037	Feb	PFRR	Craven	Tailored Trajectory
8	41.061	Feb	PFRR	Craven	TMA – Location Aid Needed
9	41.062	Feb	PFRR	Craven	TMA – Location Aid Needed
10	41.063	Feb	PFRR	Craven	TMA – Location Aid Needed
11	40.019	Feb	PFRR	LaBelle	CHARM
12	36.226	May	WSMR	Bock	
13	41.XXX	May	WSMR	Hickman	Technology
14	41.XXX	June	Andoya	Robertson	
15	41.XXX	June	Andoya	Robertson	
16	30.XXX	June	WFF	Parrott	SubSEM

FY08 Manifest

	Mission	Launch Date	Site	PI	Comments
1	36.173	Nov	WSMR	Norseick	Has been slipping for some time…
2	35.036	Dec	Andoya	Kletzing	Slipped due to funding issues
3	40.018	Dec	Andoya	Kletzing	Slipped due to funding issues
4	Brant				
5	Brant				
6	Brant				
7	Brant				
8	Surplus				
9	Surplus				
10	Surplus				
11	Surplus				
12	Surplus				
13	Surplus				
14	Surplus				
15	Surplus				
16					

Active Anomaly Investigation Boards (AIB)

Failure	AIB lead	Status
BBXII Vehicle Failure – 40.017 (Poker 2005)	NASA (Nelson)	Active - BBV Mk1 igniter design marginal. Report to be published by end of June
Terrier-Orion clamp release failure – 12.061 (WSMR 2005)	NASA (Wilcox)	Closed - 20 year old design utilized inadequate push-pin material. Design changes being implemented. Clamped system will be flown only when necessary.
Inertial ACS failure on test flight #2 – 12.056 (WSMR 2004)	NSROC (Elborn)	Closed – LN-200 error status flag caused data overwrite problem. Software changes implemented.
Power System Failure – 41.041 (Kwaj 2004)	NASA (Kotsifakis)	Closed – Electrical system shorted somewhere between the battery and the short protection in the experiment electronics. NSROC is now placing short protection at the battery
Boom Deployment System Failure – 27.145 (Kwaj 2004)	NSROC (Krause)	Closed – Clearances too tight. More appropriate clearances will be used.
Terrier-Orion Vehicle Failure – 41.046 (Kwaj 2004)	NSROC (Rosanova)	Closed – Light payload resulted in higher velocity and higher aerodynamic loads. Booster fin cant set screw failed. Tool developed to better assess aero-loads on vehicles.

Accomplishments

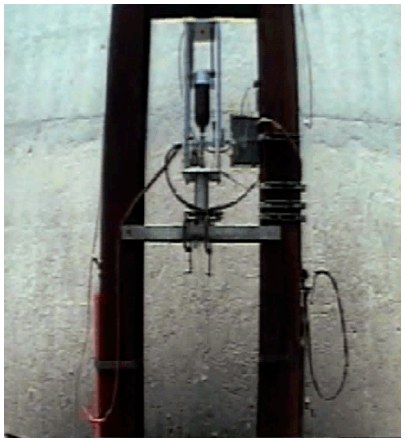
- S19-L (Boost Guidance System)
  - Existing systems will be converted to digital systems with the strap-down LN200 gyro
  - Final engineering task issued to SAAB
  - 4 units will be converted initially
- Terrier-ASAS
  - Mission Readiness Review held 0n 6/14/05
  - Changing booster fins to provide increased stability during transonic flight
  - Informal discussions on unit cost reduction underway
    - Will accelerate following successful test flight

Accomplishments

- Investigating cost reduction concepts for Andoya and Svalbard Operations
  - Eberspeaker and Ransone traveled to Svalbard for fact finding and to meet with range personnel
  - ARR is interested in a second launcher in Ny Alesund
    - The SRPO is assessing the possibility of loaning a launcher to ARR in exchange for reduce rates
    - SRPO would not fund foundation or shelter
    - Small reduction in ARR range costs my be possible
    - Additional launcher already needed to relieve conflict with Kletzing missions
  - Reduction of NASA TM asset requirements for future missions

Accomplishments

- Hybrid motor testing
  - University students are developing a paraffin hybrid rocket motor to support low-cost student flight projects
  - Shoestring funding
  - First fully successful "home-built" paraffin motor fired on June 14, 2005
  - Establishing technical and safety foundation for potential future experimentation on larger hybrid motors



Studies

- Annual Poker Operations
  - Preliminary assessment complete
  - Option appears feasible
  - To be addressed as part of a separate agenda discussion
- Kwajalein Range Option
  - Compiling cost data provided by Kwaj
  - Option appears feasible
  - To be addressed as part of the Jan SRWG Findings discussion

Upcoming Foreign Missions

- Norway (Wheeler)
  - June 2006 Launch
  - Cooperative educational mission
  - NSRP providing only the Terrier-Orion launch vehicle
  - Payload Funded by Penn State and Corporate sponsors
  - Range costs being covered by Andoya Rocket Range
- Norway (Kletzing)
  - Slipped to Dec 2007 (FY08)
  - Norwegian mission from Svalbard scheduled for same period
    - ARR says personnel should not be an issue
    - NASA launcher needed to resolve conflict
      - Best option (currently) seems to be installing NASA launcher in Ny Alesund

Technology Update

- Modest funding for Technology developments/upgrades provided from FY05 budget
  - ~$300K allocated
  - Focus is on hardware purchases to enable several engineering improvement projects to proceed
  - New technology efforts are limited due to cost
- Focus of this year's effort are
  - Electrical systems
  - Design/manufacture/test
  - Control Systems (ACS & BGS)
  - Vehicle systems
- Several of the developments will be discussed in more detail in NSROC presentations

Technology Update

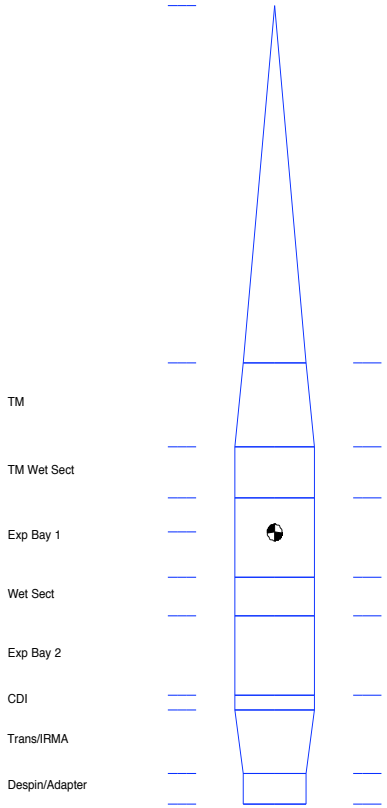
- Electrical systems
  - Goal is to increase capability, reduce cost, and increase reliability
    - Payload power distribution – simplify power distribution and wiring
    - Next generation batteries – nickel metal hydride; lithium ion
    - Low cost TM encoders
    - Next generation GPS receiver
- Design/Manufacture/Test
  - Goal is to increase the efficiency in moving through the design/manufacture/and test phases of payload development
    - Portable PCM Stack Tester – will help test PCM stacks at payload level
    - GDP Software Update – get us away from reliance on Windows95 software
    - Programmable monitor – one box to replace 7 currently in stock
    - Payload power distribution (above)
- ACS/BGS
  - ACS developments on-going; separate task to NSROC
  - Inertial ACS flight qualified on 12.062 flight
  - Celestial ACS development continues to progress
    - Will be reported on in more detail by NSROC
  - Boost Guidance System (S-19)
    - S-19 L modification proceeding with task to SAAB
    - LN-200 based S-19; necessary due to obsolete hardware
    - Two conversions being paid for by reimbursable missions
    - Qualification test flight being discussed
      - Will required a Brant flight from WSMR

Technology Update

- Vehicle Systems
  - Talos Oriole development on hold
    - Navy is not willing to provide an Oriole motor at present
    - Funding from JPL Pin Point Landing Experiment is no longer an option
      - Stop work order issued to project
    - SRPO is working with LaRC to see if they are willing to fund development in exchange for a ride to test the Inflatable Reentry Vehicle Experiment (IRVE)
  - Terrier ASAS demonstration launch
    - Advanced Solid Axial Stage motor developed by ATK, Elkton
    - Motor provided to SRPO for free via Florida Air National Guard
    - 21 inch diameter with performance similar to BB
    - Launch now scheduled for June 28
  - Orion fin redesign
    - Current Orion fins optimized for a single stage configuration
    - New design will be optimized for a two stage configuration
      - Will increase performance
      - Help with stability margin issues
    - Study followed by manufacture of test and flight demo fins
  - Surplus booster comprehensive study
    - Effort has been underway for a few years
    - More focused effort to look for new "old" motors that could be brought into the inventory
      - MLRS, Patriot, ATACMS, other
    - Performance and cost/benefit are key focus of study

Technology Update

- BBXI & XII Taurus replacement study
  - Taurus is a relatively "old" motor with
  - Help with Q and stability issues
  - Motor is currently the only Class/Div 1.1 motor in SRPO inventory
    - Explosive safety/handling/shipment issue
  - Possible replacement Terrier MK 70
- Sub-TEC payload development
  - ***Sub***orbital ***T***echnology ***E***xperiment ***C***arrier
  - Recoverable payload based on experience with Sub-SEM
  - Purpose is to provide carrier to flight demonstrate new systems and components
  - Standardization, recovery, and maximum reuse of components are key factors in the design



Findings
January 19, 2005 Meeting

I. Distribution of Launches

- The Program will fly whatever vehicle mix is required to meet science requirements

- The 15 surplus/5 Brant mix presented at the January SRWG was based on average costs for missions on the various vehicle classes.
  - Simplified computation necessary since infinite number of scenarios could be analyzed
  - Analysis based on the following approximations
    - Surplus vehicles on average have lower complexity payloads
    - BBIX vehicles on average have minimal developmental effort, but heavy subsystem requirements
    - BBXII missions on average are heavy in developmental effort, and moderate in subsystem requirements

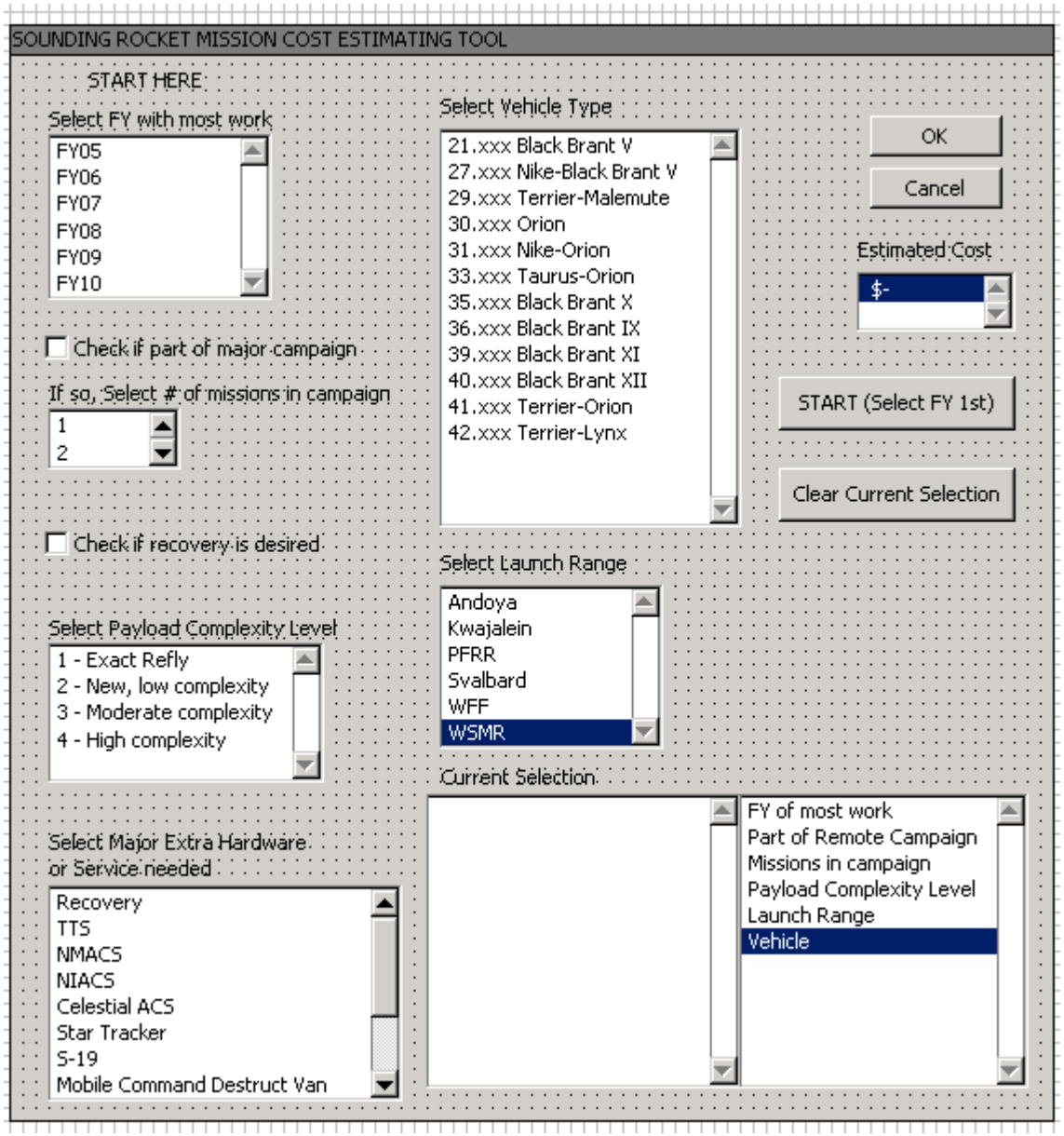
- The analysis did not consider the fact that the average payload complexity on a "surplus mission" would likely increase if more surplus mission had to be flown.
  - In reality, this would drive up the cost
  - Higher average costs would result in less than 20 missions

II. Lack of Brant Motors

- Inventory will be depleted before the end of FY06
  - SRPO plans to purchase Brants in time to avoid depletion
  - Timing of the igniter re-qualification will be critical
  - The SRPO plans to buy up to 12 Brant motors ASAP
- Poker campaign could be affected if motor purchase is not initated before November 2005 (CY)
- Good News - Funding exists
  - GSFC full cost rates dropped
  - Program intends to reduce “planned” uncosted carryover
  - Funds will be carried into FY06 to cover the purchase
- Bad News - Order delayed due to Mk1 ignition failure
  - NSROC & SRPO to travel to Bristol June 20
  - Bristol is focusing on Recovery Plan
  - BBXI test scheduled for Oct 1, 2005

III. Cost Estimates

- A simplified tool is being developed to provide cost estimates for proposals
  - Turn around should be fairly quick
  - Moderate fidelity will be provided so proposers can validate SRPO understanding of mission requirements
- Factors contributing to the costs
  - Payload Complexity (as it relates to NSROC effort)
  - Subsystem Requirements (TM links, ASC, S-19, recovery, etc)
  - Vehicle Type
  - Range Support Costs
    - Will consider "variable" costs associated with range support
    - Will likely have to consider historical averages to allocate range costs for Poker, Esrange, and Andoya missions
  - Travel and Logistics
- Use of data (SRPO theory)
  - Incorporation of data into proposals serves to regulate requirements levied by proposers
  - HQ ranks proposals on science merit and considers cost/benefit as appropriate.
  - SRPO analyzes ranked list to see how many missions can be accommodated
- The SRPO does not plan to change how it interacts with science teams or how projects are implemented


SOUNDING ROCKET MISSION COST ESTIMATING TOOL
START HERE
Select FY with most work
FY05
FY06
FY07
FY08
FY09
FY10
Check if part of major campaign
If so, Select # of missions in campaign
1
2
Check if recovery is desired
Select Payload Complexity Level
1 - Exact Refly
2 - New, low complexity
3 - Moderate complexity
4 - High complexity
Select Major Extra Hardware or Service needed
Recovery
TTS
NMACS
NIACS
Celestial ACS
Star Tracker
S-19
Mobile Command Destruct Van
Select Vehicle Type
21.xxx Black Brant V
27.xxx Nike-Black Brant V
29.xxx Terrier-Malemute
30.xxx Orion
31.xxx Nike-Orion
33.xxx Taurus-Orion
35.xxx Black Brant X
36.xxx Black Brant IX
39.xxx Black Brant XI
40.xxx Black Brant XII
41.xxx Terrier-Orion
42.xxx Terrier-Lynx
Select Launch Range
Andoya
Kwajalein
PFRR
Svalbard
WFF
WSMR
Current Selection
FY of most work
Part of Remote Campaign
Missions in campaign
Payload Complexity Level
Launch Range
Vehicle
OK
Cancel
Estimated Cost
$-
START (Select FY 1st)
Clear Current Selection

IV. HQ Review of SR Operations and Cost

- "High Performance" is a term that has been used by the SRPO, and thus it was adopted by the review team. It's a case of semantics..

- While the SRPO can not provide authoritative insight into the Review Panel's meaning, discussions during the review seem to indicate "reduction of the requirements" can also relate to the number of missions flown.

V. Access to NSROC Data Base

- Most efficient method appears to be an FTP site
- Site will be set up with Directories
- PI's will be given passwords

- More detail will be provided by NSROC in the afternoon session

VI. Mesospheric Rocket Development

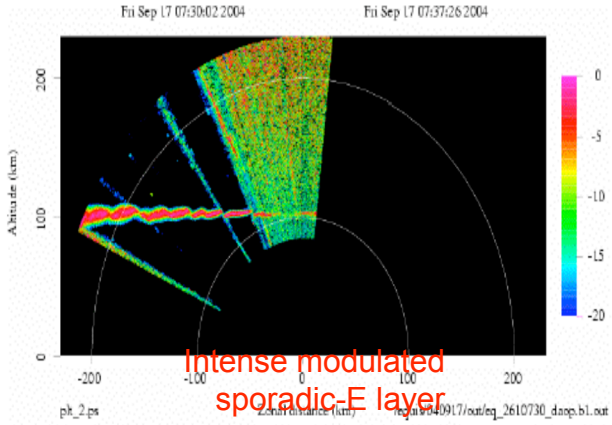
- 8 MRLS motors at Wallops
- 15 more motors being processed for transfer to SRPO (warhead removal)
- Vehicle would be partially based on an existing design
- Development on hold due to efforts associated with other vehicle development efforts
  - The landscape has changed and thus priority may shift
- NSROC will provide details during the afternoon session

VII. Kwajalein Standard Range Support (cont)

- SRPO is looking to provide a range for equatorial research opportunities
  - Kwajalein is being considered based on EQUIS II experience
  - Goal is to consider "single" missions as compared to campaign
- Baseline
  - No NASA TM or Radar assets required
    - Next Generation Wind Weighting System will be used
      - Qualified and used for EQUIS II
    - New approach will be to use GPS sondes
    - Augmentation of TM readout equipment may be necessary
  - Two launchers are baseline
    - Will require one time SRPO investment of ~$200K
  - Cost must be kept to a minimum to be feasible
- Kwajalein is very interested in the future possibilities
  - Cost sharing options have been discussed
  - Cost estimate process underway
    - PRD submitted for "standard" mission in March
    - Cost estimate expected any day
    - Several scenarios are being estimated to help in making our decisions - buildup activities, one launch, two launches, etc.

VII. Kwajalein Standard Range Support (cont)

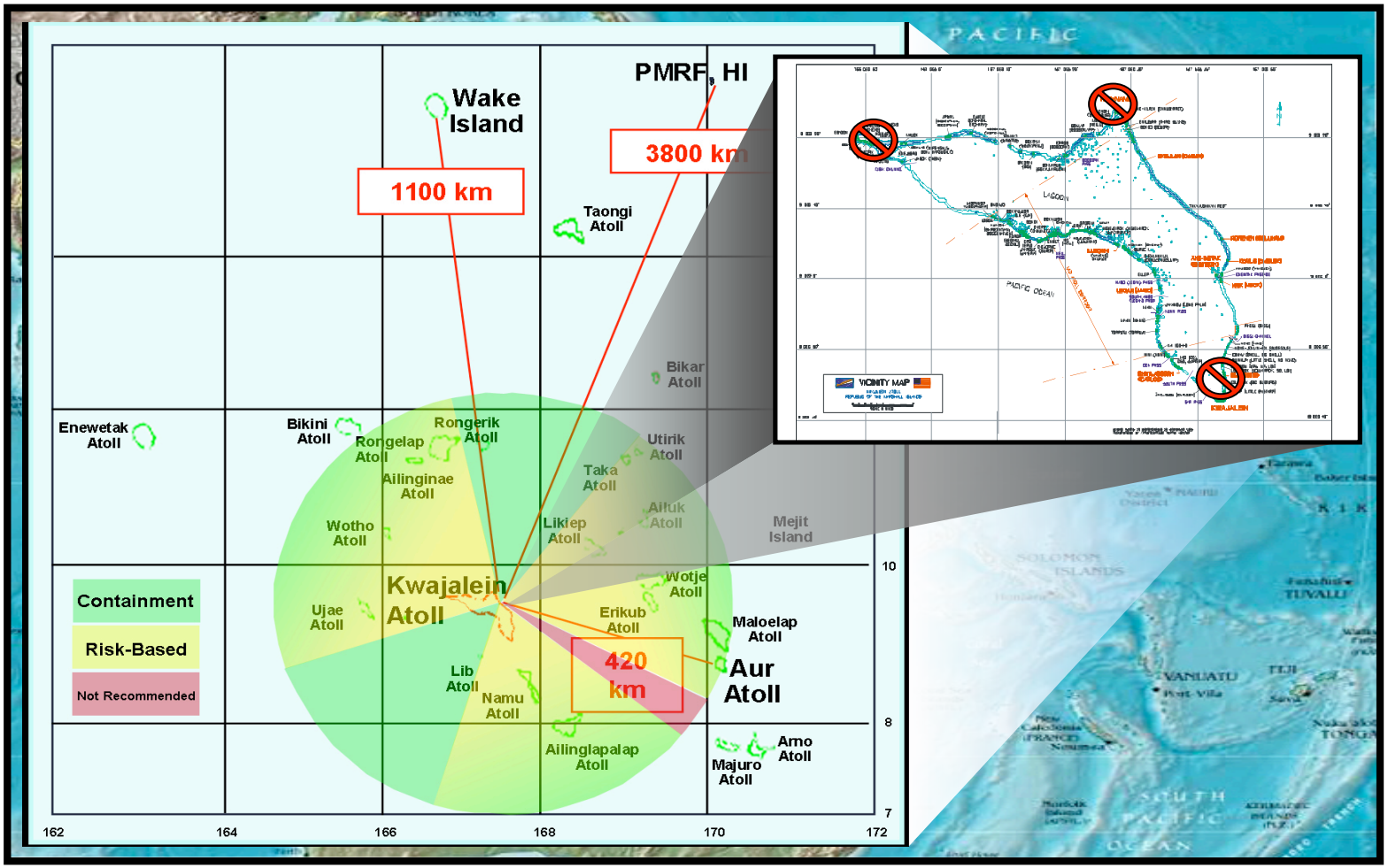
- Science Instrumentation
  - ALTAIR is the main drawing card
  - High power dual frequency (VHF/UHF) scanning radar
  - Waveform modifications incorporated as part of EQUIS II
  - Recent upgrades in data acquisition and display systems major plus
    - Reduces cost
    - Improves capability/flexibility
    - Utilized during EQUIS II



VII. Kwajalein Standard Range Support (cont)

- Kwajalein safety recently published new trajectory guidelines that expand our possibilities
- Risk based trajectories are now a standard feature
- Will allow southerly launches based on risk analysis
- Restrictions include
  - No direct overflight of Roi-Namur, Kwajalien, or Ebadon
  - No launch towards Majuro (capital of Republic of Marshall Islands)
- Next slide shows possibilities

VII. Kwajalein Standard Range Support



Poker Range Operations

FY07 Campaign

- 10 Missions in two month period
- Schedules must be maintained!
- Already anticipate significant amount of overtime
- 5th launcher to be installed at range
  - Allows 2 missions to be staged simultaneously
  - March can serve as backup window

Baseline Poker Capabilities

- 2 large and 2 small launchers
  - Possibility of 1 additional launcher
- 1 tracking radar
- 2 TM tracking antennas
- 2 or more down range optical sites
  - All sky cameras, photometers, magnetometers, etc
- Science Radars
  - Anchorage Site?
  - AMISR (to be installed)

Poker Range Costs (approx.)

- Annual Cost (required to keep the range in existence)
  - Staffing: $ 558 K
  - Equip, Mat & Supplies: $ 358 K
  - Other Services: $ 93 K
  - Electricity: $ 177 K

  $ 1,186 K

- Operations Costs (every other year)
  - Staffing: $ 220 K
  - Equip, Mat & Supplies: $ 200 K
  - Other Services: $ 90 K
  - Electricity: $ 30 K

  $ 540 K

Estimated "worst case" for Poker contract estimate.
Cost typically varies between $300K and $400K.

Poker Logistics Costs (approx.)

- Motor Shipment: $ 20K per truck load
- Payload Shipment: $ 10K - $ 15K per payload
- Travel: $ 40K - $50K per team per 20 days

Average Poker Range Support Cost Per Flight for Every-Other-Year Scenario

Poker – every other year operation (8 flights)	
Cost for Core Capability (for 2 year period)	$ 2,400 K
Ops Cost	$ 500 K
Motor Shipment (1 truck load)	$ 20 K
Payload Shipment (all payloads)	$ 96 K
Travel	$ 150 K
	$ 3,166 K

$ 396K per flight

Per-flight cost dependent on number of mission in the “campaign”

Annual Poker Operations

Question: Is there any advantage to conducting Poker operations on a yearly basis?

- **Benefits**
  - Provides NSROC work load leveling
  - Provides backup opportunities for weather issues or schedule slips (potential to help workload leveling)
  - Shorter down time for Poker personnel between operations
- **Cost**
  - Overall Poker cost will be approx. $200K higher over two year period
    - Assumes some efficiencies are lost
    - Relative cost might be lower in some years and higher others – depends on mission profiles
    - Cost increase not significant when potential savings in OT during payload preparation at WFF is considered

Average Poker Range Support Cost Per Flight For Annual Scenario

Poker – every year operation (4 flights)	
Cost for Core Capability (1 year)	$ 1,200 K
Ops Cost	$ 300 K
Motor Shipment (1 truck load)	$ 20 K
Payload Shipment (all payloads)	$ 48 K
Travel	$ 100 K
	$ 1,668 K

$ 417K per flight

Per-flight cost dependent on number of mission in the “campaign”

Andoya Range Operations

Baseline Andoya Capabilities

- 2 large and 1 small launchers
  - Possibility of 1 additional launcher
- 1 tracking radar (German)
- Telemetry
  - On site: Two systems (?)
  - Remote: Tromso, Longyearbyne
    - Need to augment w/ personnel and equipment
- ALOMAR (Andoya)
  - LIDAR
  - MF and VHF Radars
- EISCAT (Longyearbyne)
- Data Center with displays of all Svalbard and Andoya science data
- 2 or more down range optical sites w/ basic instrumentation

Andoya Rocket Range

- Andoya
  - $250K - $300K for typical 20 day operation
  - Costs do not typically increase as more missions are added
    - Increased duration will add about $6K per day
    - Increased demand (e.g. excessive OT and remote TM sites) add cost
  - 2 large and 1 small launcher will be available in coming years
- Svalbard
  - $400K - $500K for typical 20 day operation
  - Costs do not typically increase as more missions are added
    - Increased duration will add about $6K per day
    - Increased demand (e.g. excessive OT and remote TM sites) add cost
  - 1 large launcher available
  - Investigating long term loan of large NASA launcher
    - ARR is assessing how loan may help reduce generic operations costs
    - ARR would fund the foundation and shelter (assumption)

Andoya Logistics Costs (approx.)

- Motor Shipment: $ 27K per container
- Payload Shipment: $ 15K - $ 20K per payload
- Travel: $ 50K - $60K per team per 20 days

Average Andoya Range Support Cost Per Flight

Andoya (4 flights)	
Ops Cost	$ 400 K
Motor Shipment (1 container)	$ 27 K
Payload Shipment (all payloads)	$ 68 K
Travel	$ 200 K
	$ 695 K

$ 174K per flight

The per-flight cost can vary from $150K to $500K depending on the number of flights in the “campaign”

ESA member countries provide core range funding, and NASA pays only for the services associated with actual operations

Conducting Poker and Norway/Kwaj Operations in Same Year

- **Critical Considerations**
  - NSROC
    - Existing motor crew personnel are able to cover parallel ops at Poker and Norway
    - Careful project team planning would be required
  - Near Earth Network Services (NENS)
    - Personnel will be stretched thin covering Poker, Norway and Wallops in parallel – but possible
    - Will require reliance on Norwegian assets for data acquisition
      - Baseline assumption to keep costs down
        - » Proposals requiring mobile antennas and vans may not be cost effective
      - Launch scenarios w/ multiple rockets may result in no redundancy
        - » Complex missions may result in unacceptable risk
      - NENS personnel and equipment would be stationed at Norwegian TM sites
    - Payload complexity would have to be carefully coordinated
      - Limit on number of total TM links that can be supported
    - Investment in additional equipment likely required
      - Receivers, combiners, decoms, recorders, etc)

Conducting Poker and Norway/Kwaj Operations in Same Year

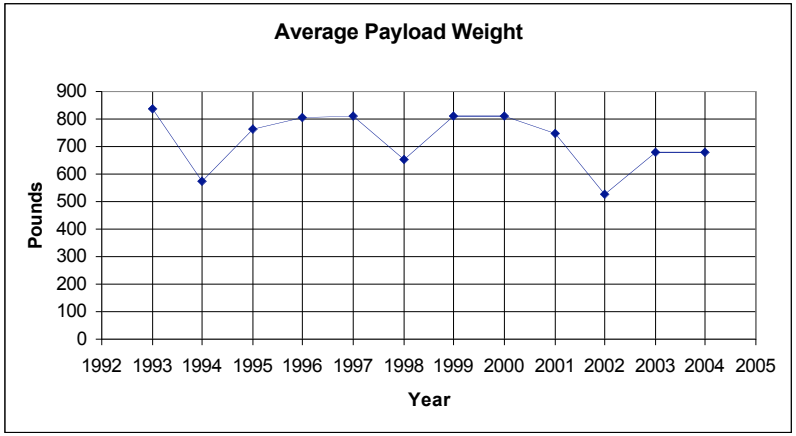
- **Critical Considerations (cont)**
  - Mission mix must be carefully coordinated to avoid overload
    - Number and complexity of missions needs to be limited when parallel operations are undertaken
      - Shifting from 8 Poker missions to 4 Poker + 4 Andoya missions doesn't help the workload situation
      - Consequence of offering this option is smaller "clusters" per site and maybe less complicated missions (fewer TM links)
    - Ideal Mission Mix
      - June/July Kwajalein (1 mission)
      - Nov/Dec Norway (2 to 3 missions)
      - Jan/Feb Poker (3 to 4 missions annually)

      } Alternate on a yearly basis?
    - It is possible to transfer TM equipment (receivers, recorders, etc) from Nov/Dec Andoya operation to cover Feb/March Poker operation
      - Very tight logistics scheduling
      - Cost typically high since airfreight is required
    - More detail required in proposals so support requirements (e.g. quantity of links, data rates, beam width, etc.) can be accurately assessed for resource conflicts

Rocket Motors and Vehicle Development

Vehicle and Payload Trends

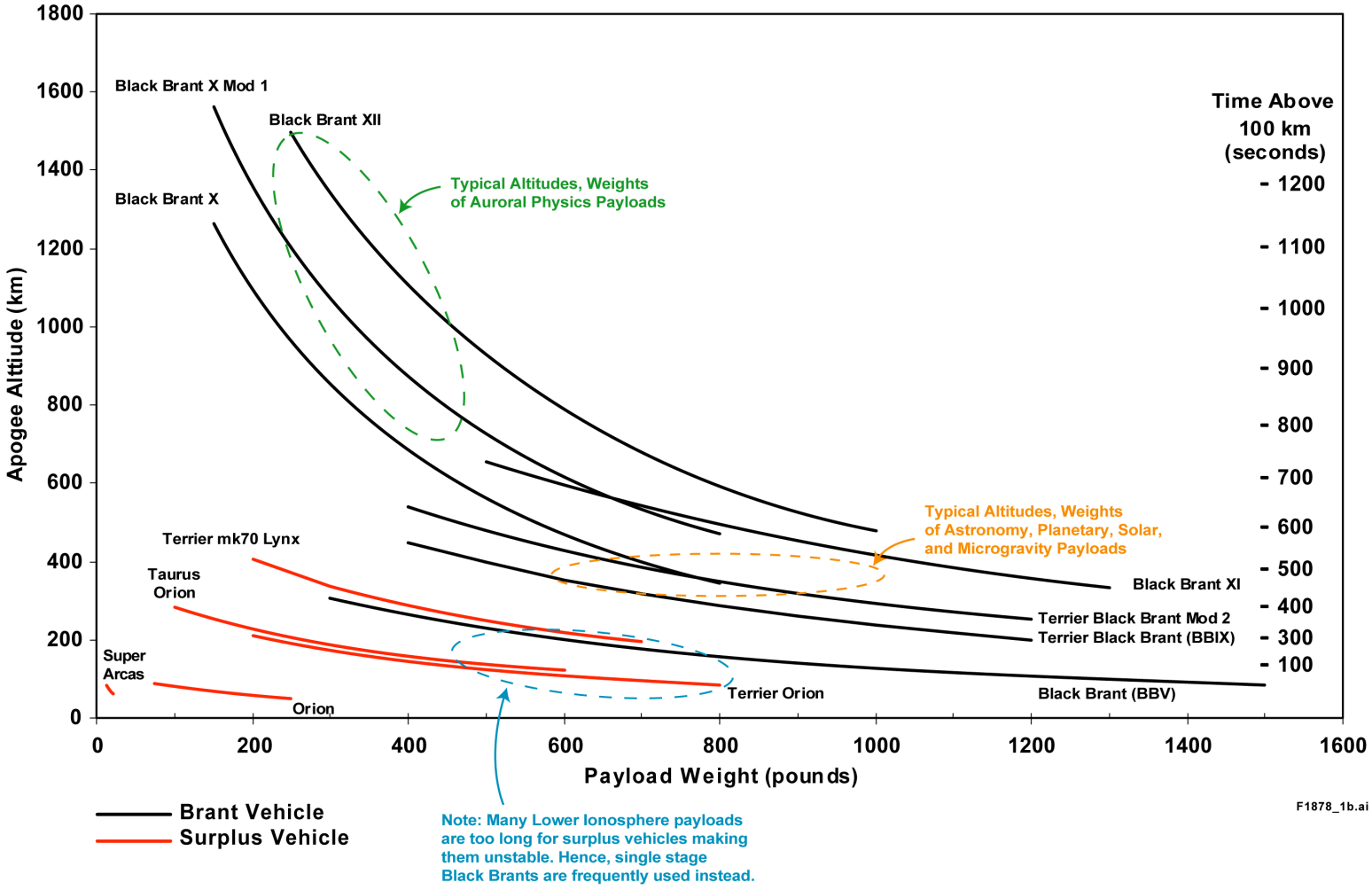
- Historical (1994-2004)
  - 63% Brant-class
  - 37% Surplus
- FY 05
  - 31% Brant-class
  - 69% Surplus
- FY 06
  - 67% Brant-class
  - 33% Surplus
- FY 07
  - 50% Brant-class
  - 50% Surplus



Average payload weight has not grown since the early 1990's

- Astronomy payloads are relatively heavy
- Most geospace "prime" payloads need to fly high
- Geospace "support" payloads typically use surplus vehicles

NASA Sounding Rocket Vehicle Performance



Heritage Rocket Motor Status

- Black Brant Motors
  - 13 Std Brants currently in inventory
  - 2 Mk1 Brants currently in inventory
  - Will run out before the end of FY06 if motors are not purchased
  - Igniter issue needs to be resolved before order can be placed
  - Targeting October 2005, for BBXI qualification flight
- Nihka Motors
  - 11 units currently in inventory
  - Bristol no longer produces the “standard” Nihka
  - ATK and Bristol could probably produce a replacement, but there will be a development cost
  - Development/Acquisition plan has yet to be developed by the SRPO
- Talos
  - 20 motors currently in inventory
  - 14 more motors tagged for Sounding Rocket Program

Heritage Rocket Motor Status

- Nike Motors
  - Very old, refurb hazards outweigh benefits
  - No longer being used by the program
- Terrier Motors
  - Plenty of Mk12 and Mk70 versions available
  - Will serve as booster workhorse
- Malamute
  - 5 Malamutes available
  - Reserved for unique applications

"New" Rocket Motor Status

The SRPO continues to investigate the use of surplus motors to expand program capabilities. Two motor systems are showing promise:

- Patriot (surplus)
  - Terrier-Patriot could replace portion of single stage Brant vehicles
  - Have requested 50 units from Army
  - Feedback from DoD contact increasingly positive
- MLRS (surplus)
  - Tentatively called the "Mesquito"
  - Will provide 4.0-inch dia. dart payload
  - Motors in-hand, development in limbo
  - Priority to be reassessed

"New" Rocket Motor Status

- Orioles
  - 22-inch diameter
  - 3 motors flown for DoD as of June 2005
  - Cannot afford to make initial purchase with SMD funding
  - Development on hold until external funding is obtained

- Advanced Solid Axial Stage (ASAS)
  - 21-inch diameter
  - 0 motors flown as of June 2005
  - Cannot afford to make initial purchase with SMD funding
  - If upcoming test flight is successful, the SRPO will intensify discussions on cost reduction options